The American STATISTICIAN

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The American STATISTICIAN

A publication of the American Statistical Association, successor to the *A S A Bulletin.*

Entered as second class matter March 11, 1938, at the post office at Washington, D. C., under act of March 3, 1897. *The American Statistician* is published six times a year—February, April, June, August, October and December—by the American Statistical Association, Editorial Office: 1603 K Street, N. W., Washington 6, D. C. Subscription rate: one dollar and fifty cents a year or twenty-five cents per copy.

THE AMERICAN statistician as a person represents the application of a relatively new scientific technique in a wide variety of subject matter fields. The American statistician is a technician; he is an interpreter according to scientific standards; he is a user of economic, social, physical, and biological data; he is a person interested in the application of the most objective procedures to the numerical or measurement aspects of information relative to every part of life. During recent years in the United States the work of the American statistician has grown rapidly in volume and in importance and will continue to grow as his scientific approach becomes the responsibility and privilege of every citizen.

THE AMERICAN STATISTICIAN as a new publication will attempt to implement the growth of American statisticians. It will not be a substitute for any of the Association's technical publications. It will be an adjunct to them, and an aid in professional development. It will provide an editorial medium for the Association, to be used whenever editorial strictures are considered essential. It will present the story of the actual uses—successes and failures—of statistical methods in many fields. By illustration it will stimulate the adaptation of statistical methods to fields heretofore considered as not appropriate for the application of such methods. It will provide for the interchange of news between chapters and will tell of the interesting problems of American statisticians. It will currently provide a means for the interchange of questions and answers and the presentation of problems in an informal way. It will carry regularly the official and unofficial announcements of the American Statistical Association concerning new projects, meetings, and activities of the Association's sections. It will welcome contributions, and will open its pages to discussion and debate.

Introduced in August 1947, it is hoped that THE AMERICAN STATISTICIAN will in this issue provide one of the first welcoming signs to our many distinguished visitors from foreign lands who will be in the United States in September for the World Statistical Congress.

THE EDITORS

NEWS

U. S. National Income Series Revised—Congress Votes No on Censuses of Business and Manufactures—Britain Revises Living Cost Index—U. S. and U. K. Surveys Uncover Lacks in Statistical Training—Forthcoming Statistical Conferences

Major Revisions Made in National Income Data

In a special July supplement to the *Survey of Current Business,* revised monthly series of national income, national product and personal income are presented for the period 1929–46 inclusive. The supplement contains the basic detailed tables and an account of the conceptual changes introduced. Copies can be obtained from the Department of Commerce for 25 cents.

The principal effects of this revamping of the Department of Commerce national income series are: (a) to increase estimated national income for the period as a whole and particularly for the war period; (b) to increase estimated consumer expenditure and (c) to reduce estimated personal savings.

The dominant motive in the revisions has been to measure purchases of goods and services consistently at the nearest possible approximation to current market value in the gross national product series. Probably the two most important changes from a quantitative standpoint are: first, to carry corporate profits before, rather than after, taxes in national income, and, second, to include payments to military personnel in kind, military life insurance benefits and dependents' allowances in both income and gross national product. Among the other revisions in method are: (a) exclusion of interest payments on government debt on the theory that since most of this debt was incurred to finance war or military preparations, it is economically unproductive; (b) addition of imputed net rent on owner-occupied dwellings and charging of depreciation and taxes on these dwellings to consumer expenditure; (c) elimination of depletion allowances from national income; (d) a broader coverage of inventory changes and evaluation adjustments; (e) elimination of government subsidies to private enterprise and (f) readjustments in the field of private pension and welfare funds.

The Commerce Department announces that a comprehensive volume will be forthcoming dealing with the detailed changes in definition, statistical method and coverage, and elucidating the theoretical problems involved.

Censuses of Manufactures Bill Fails

H. R. 1821, which provides for censuses of business and manufactures at frequent intervals, failed of passage at this session of Congress. It was supported by the American Marketing Association and the American Statistical Association among other national groups. Advocates of the measure are planning to revise it for introduction before the next Congress.

New British Cost of Living Index Appears

On June 17, the 1914 British cost of living index, generally considered to have been obsolete for at least the last 20 years, passed out of existence and a new temporary index was substituted. The woeful inadequacy of the old index as a reflection of the consumer expenditures of British labor is indicated by the fact that 60 percent of the weights were assigned to food and only 4 to "other items."

The new temporary index is based on 1937/38 expenditure, assigns 35 percent of the weights to food, 16 percent to "other items" and 24 percent to goods and services which were not included at all in the 1914 index. Motion pictures, football games, tobacco, drink, radios and floor polishes are among the items now included which were evidently considered beyond the means of workers in 1914.

Some 2,500,000 British workers in major industries have collective contracts based on the official index. A revision of these wage agreements has now become necessary. The London *Economist* suggests that publication of the ad interim cost of living index heralds the abandonment of British food subsidies, a decision which would have automatically increased by 60 percent the wage payments to 2,500,000 workers whose contracts are linked to the cost of living index. The new index, by reducing the food component, will damp down the automatic wage increases and lessen the inflationary impact on the British economy as a whole.

British Statistical Training Deemed Inadequate

In a 1946 report to the Council of the Royal Statistical Society, a special committee, chaired by Egon S. Pearson, calls attention to quantitative and qualitative deficiencies in the statistical training facilities offered British students. In view of the increased application of statistical method to both the natural and the social sciences, the Committee suggests that the statistical approach "may ultimately be introduced in schools." The report proposes that all students of the social and natural sciences be provided with instruction in elementary statistical analysis. More statistics courses are necessary in British colleges and universities, it is held, to bridge the gap between the demand for trained statisticians and the present inadequate supply. The Committee recommends three main types of courses: (a) a general familiarization course of studies; (b) more advanced courses to enable science students to apply statistical analysis adequately to their chosen subject fields, and finally (c) advanced courses to train specialists in the various fields of mathematical statistics.

Provocative Report on Personnel and Training Issued by the National Research Council

is No. 128 of its Reprint and Circular Series, May 1947. "There has been an unprecedented growth of interest in the use of statistical methods during the past ten years, which has caught the American educational system unprepared," is the Council Committee's first conclusion.

"There is a shortage of adequately trained statisticians in both academic and nonacademic categories and a more severe shortage is expected."

"The shortage of training facilities for mathematical and especially for applied statisticians is critical."

The Committee, which included Luther P. Eisenhart, Samuel S. Wilks, Chester I. Bliss, Edward U. Condon, Harold O. Gulliksen, Lowell J. Reed, Charles F. Roos, Walter A. Shewhart, Hugh M. Smallwood, and Frederick F. Stephan, made twelve recommendations about statistical training, from the secondary to the post-graduate level.

There will be a discussion of the survey by Professor S. S. Wilks in an early issue of *The American Statistician*.

The American Society for Testing Materials

issued its Index to 1946 A. S. T. M. Standards in June. Copies of the 242 page publication are furnished without charge on written request to A. S. T. M, Headquarters, 1916 Race Street, Philadelphia 3, Pennsylvania.

United Nations Chooses 1937 as Base Year

The United Nations and its affiliated agencies have made an ad interim decision that all statistical series are to be based on 1937 until a new base year may be selected. The change was effective for the UN's *Monthly Bulletin of Statistics* beginning with the May issue, 1947.

Frederick F. Stephan Named Director of 5 Year Survey of University Education

Princeton University has announced plans for a comprehensive statistical survey in the field of higher education. It will begin with statistical analyses of university records of the student's standing at entrance, his scholastic aptitude rating and his academic and extracurricular records.

The survey will analyze the correlation between entrance standing and academic accomplishment, the influence of health, deportment and extracurricular activities on academic performance, the specific features characterizing the experience of students who have failed, who have achieved notable success, who fell below their predicted achievement, or who surpassed prediction. The evidence from student records concerning the comparative efficacy of lecture, class and laboratory for different types of students will be evaluated. The survey will range from an examination of the experience of special groups, such as veterans, students of high standing and probation cases, to specific experiments in instructional techniques carried out under controlled conditions.

American Statistical Association 107th Annual Meeting

New York City, December 29-31, 1947
Hotel Commodore
42nd Street at Grand Central Terminal

International statistics and the status of statistics in the United States will receive major attention on the program.

Sessions are being prepared in cooperation with the American Sociological Society, the Vital Statistics Section of the Public Health Association and the New York Chapter of the American Statistical Association.

There will be several sessions of contributed papers. Write to Lester S. Kellogg, Secretary, American Statistical Association, 1603 K Street N.W., Washington 6, D. C., if you wish to present a paper.

All sessions are open to the public. Make your reservations early.
Hotels in the neighborhood: Biltmore, Lexington, and Roosevelt. Rates $3.50 up.

Frank Yates at Department of Agriculture Graduate School. Sponsored by Experimental Design Committee

Frank Yates of Rothamstead, world leader in Experimental Design, will give three lectures in Washington on September 15, 16 and 17. The lectures are sponsored jointly by the Experimental Design Committee of the Department of Agriculture, and the Department's Graduate School. Those interested in attending can secure tickets at the Graduate School of the Department of Agriculture.

Centenary Celebrations in Dublin Planned by Statistical and Social Inquiry Society of Ireland, October, 1947

The Statistical and Social Inquiry Society of Ireland, founded in 1847, will celebrate its Centenary at Dublin, October 6 through 10. The meetings have been timed especially to make it possible for members of the International Statistical Institute, attending the 25th session at Washington in September, to break their return journey in Ireland. Details of the program will be given in one of the *News Letters* issued in connection with the International Statistical Conferences in Washington.

Institute of Mathematical Statistics Announces Sessions for September 2–4

The 1947 Summer Meeting of the Institute will be held at Yale University, New Haven, Connecticut, on September 2–4, 1947, in conjunction with meetings of the American Mathematical Society and the Mathematical Association of America.

The afternoon session on September 2 will be a Symposium on 2×2 Tables, chaired by Lowell J. Reed. Papers to be given are, Tests of Significance by Churchill Eisenhart, Estimation by Charles P. Winsor, "Non-Standard" Cases by Joseph Berkson. Discussions will be by William F. Taylor, Frederick Mosteller, David Blackwell, and John W. Tukey.

Wednesday morning, September 3, Professor Fisher, of Cambridge University, will speak.

The Thursday sessions will include a business meeting. The Rietz lecture, which will be delivered by A. Wald, will deal with Sequential Estimation and Multiple-Decisions. At the Thursday sessions of the American Mathematical Society, Samuel S. Wilks will speak on Sample Theory Order Statistics. A number of contributed papers will be given on Thursday afternoon at a joint session with the American Mathematical Society.

First International Biometrics Conference

An informal international conference of biometricians is to be held on Friday and Saturday, September 5–6, at the Marine Biological Laboratory in Woods Hole, Massachusetts. Foreign delegates to the International Statistical Conferences with an interest in biometry have been invited to attend.

Four sessions are planned, with papers and discussions by foreign biometricians. One session will be led by Professor R. A. Fisher of the University of Cambridge, who will speak on "A Quantitative Theory of Genetic Recombination." Another will consider how international cooperation in the mathematical and statistical aspects of quantitative biology can best be advanced.

There will be opportunity to inspect the facilities of the Marine Biological Laboratory and of related organizations in the vicinity. The sessions are open to all who may be interested. Further information can be obtained from C. I. Bliss, Chairman of the Organizing Committee, Box 1106, New Haven 4, Connecticut.

A Welcome to the International Statistical Conferences

by **W. AVERELL HARRIMAN**
Secretary of Commerce
Chairman, American National Committee

The convening in Washington this September of six great International Statistical Conferences, bringing together the foremost statistical talents of almost every nation in the world, marks a major step toward the reestablishment of international professional relationships. The World Statistical Congress called by the United Nations and the concurrent sessions of the International Statistical Institute, the Inter American Statistical Institute, the Econometric Society, the Inernational Union for the Scientific Investigation of Population Problems, and an organizing session to establish an International Association for Research in Income and Wealth will provide an unusual opportunity to revitalize international scientific communication in the field of statistics and to contribute toward the development of a world statistical system. The American Statistical Association, as the host statistical society, is contributing greatly to the success of these conferences by arranging certain of the scientific programs for the International Statistical Institute and the Econometric Society as well as an exhibit of graphic material.

American Government is host

The American Government and the American people have an abiding interest in the purposes of these conferences, and as a government we have worked with the United Nations and its specialized agencies to forward such a development. As host nation we have invited delegates from 63 nations to the 25th Session of

the International Statistical Institute and from 21 nations to the First Session of the Inter American Statistical Institute.

President Truman is Honorary Chairman

To express our deep interest in these conferences and to work for the success of the sessions there has been set up an American National Committee with President Harry S. Truman as Honorary Chairman. Broadly representative of American life, the committee wishes to give to our overseas guests the strongest assurances that the American people heartily support the work they are undertaking.

The Finance Committee

The work of the American National Committee has centered around efforts to assure the widest possible participation from all countries in the world. Under the Chairmanship of Mr. Thomas J. Watson, a Finance Committee has collected from the American people, research institutions, and American industry a fund which has been used to help to finance the meetings. In addition, we have sought to arrange lectureships and business consultantships for a number of the invited delegates.

The hospitality committees

As an auxiliary activity the American National Committee has established under the Chairmanship of Mrs. Edwin G. Nourse, a Washington Hospitality Committee. This committee has been arranging social functions and similar activities to provide an opportunity for that less formal exchange between our statisticians and those of other countries which can be so helpful in establishing a wider knowledge and appreciation among all nations. A Hospitality Committee for New York under the Chairmanship of Miss Helen Slade has been arranging for the reception of our overseas participants in New York and for activities of interest to them in that city.

As Chairman of the American National Committee, I deeply appreciate the honor which we have been given in being asked to contribute to the success of these conferences.

A. S. A. Programs

Arranged for the 25th Session of the INTERNATIONAL STATISTICAL INSTITUTE

FRIDAY–SEPTEMBER 12, 1947

Afternoon — **Sampling Theory in the United States**
Arranged for the Econometric Society
Chairman: William Feller

Papers:
- Recent Developments in Sampling Theory in the U. S.—William G. Cochran
- Sequential Analysis—Abraham Wald
- Sampling Theory in Recent Years—Frank Yates

Discussion: Bertil Mattern—Pei-Ching Tang—Leo W. Tornqvist

SATURDAY–SEPTEMBER 13, 1947

Morning — **Development of Sampling Practice in the U. S.**
Arranged for the Econometric Society and International Statistical Institute
Chairman: Helen M. Walker

Papers:
- Sampling of Human Population—Morris H. Hansen
- History of the Uses of Sampling Procedure—Frederick F. Stephan
- Commercial Uses of Sampling—J. Stevens Stock and Dr. Joseph Hochstim

Discussion: R. J. Jessen—P. C. Mahalanobis—J. W. Nixon

Afternoon — **Developments in Substantive Economic and Social Statistics**
Arranged for the International Statistical Institute
Chairman: Isador Lubin

Papers:
- The Bureau of Labor Statistics Program—Ewan Clague
- Recent Developments in Business and Marketing Statistics—Ross M. Cunningham
- The Social Security Statistics Program—I. S. Falk
- The Census Program—Philip M. Hauser
- The Agricultural Statistics Program—Charles F. Sarle

PROGRAM OF THE CONFERENCES

The principal aims of the International Statistical Conferences will be to explain the statistical program of the United Nations and the "specialized" international organizations, to discuss recent statistical developments throughout the world, to present leading national developments in statistics, to adjust the statistical activities of the various societies to recent developments in international organization, and to consider new methods of fostering international cooperation in the improvement of statistics.

The Conference will be open only to delegates and invited guests. Among the programs scheduled by the World Statistical Congress are *The Role and Work of the Statistical Commission and the Statistical Office of the United Nations in the Development of International Statistics, The Role and Work of the Specialized Agencies in International Statistics, The Development of International Standards and of International Comparability of Statistical Data, with Comments on the Developments in Such Fields as International Trade, Balance of Payments, and Industrial Classification, The Role of the Population Commission and the Development of International Population Statistics, The Present Status of International Income Data with an Outline of the United Nations Programs in this Field, Need for an International Subject Classification for Statistical Materials.*

The International Statistical Institute program will include *Uses of Probability Theory in Social Science, Recent Trends in Analysis, Public Opinion Research, Experimental Design in the United Kingdom and the United States, World Census of Agriculture and Population, Social Security and Health Statistics.*

The Inter American Statistical Institute will discuss *National Problems of Supplying Data to International Organizations, Foreign Trade Statistics in the Americas; Classification Problems, Statistical Training Methods and Materials in the Americas: Tentative Program Proposed by the Committee on Statistical Education.*

Econometric Society sessions include *Statistical Analysis of Economic Relationships, Use of Econometrics in Private Business, Econometrics of International Economic Relations, Statistical Inference, Theory of Choice and of Utilization of Resources, Econometrics and Prevention of Inflation and Unemployment.*

SESSIONS PREPARED BY A.S.A. ARE OPEN HOUSE

By agreement with the Joint Arrangements Committee for the International Statistical Conferences, the programs arranged by the Association for the International Statistical Institute and the Econometric Society are open to all A.S.A. members. The three sessions arranged by the A.S.A. Program Committee were planned to give our foreign colleagues a clear summary of the more important accomplishments in statistical work in the United States during the past ten years. They are timed to make it possible for U. S. statisticians who are not invited to the closed sessions of the Conferences to arrive at mid-day on Friday, September 12, and stay through the American Statistical Association reception for delegates to the Conferences.

The officers of the Association have invited the delegates to the Conferences to come to a reception at the Shoreham Hotel, on Saturday, September 13, from 5 to 7 P. M. All A.S.A. members are invited to take advantage of the opportunity to meet and talk to the foreign delegates.

SPECIAL FEATURES OF THE CONFERENCES

The American Statistical Association, which is serving as host to the conferences, announces that a comprehensive display of mechanical and visual aids to statistical analysis and interpretation will be shown at the meetings. The displays, which will be shown in the Shoreham Hotel, include the latest technical developments in computing and calculating machines, statistical typewriters and visual methods of presentation. The A.S.A. committee on Graphic Presentation is arranging a special exhibit of the methods of presenting statistical material in use by U. S. business, industry and government. A cross section of the more important publications in the textbook, statistical research and specialized mathematico-statistical fields will be available for examination. It is felt that these displays of visual presentation methods, texts and specialized publications will be of particular value to delegates from wartorn European and Asiatic countries who were unable, during the war years, to keep abreast of developments in statistics.

The September 1947 issue of the *Journal of the American Statistical Association,* will be a special International Statistical Conferences Issue and is to be distributed gratis to delegates. A limited number of sets of back issues of the Journal will be made available without charge for foreign libraries and scientific institutions.

CONFERENCE COMMITTEES

The ASA Program Committee for the World Statistical Conferences comprised: Willard L. Thorp, Philip M. Hauser, Jacob Marschak, Jerzy Neyman, George W. Snedecor and Aryness Joy Wickens. The graphic display at the conferences was arranged by a committee composed of: Kenneth W. Haemer, Alford Archer, H. C. Barton, Jr., A. E. Batchelet, John D. East, Ralph W. Hurlin, Frank Jahrling, William A. Neiswanger, David M. Schneider and Paul Wiers.

Statistical Engineering

by ROBERT C. TUMBLESON

Although the laws of probability were developed formally and elegantly by the great 18th and 19th century mathematicians, for years they were applied only by gaily dressed gamblers on the river boats and in the casinos. Insurance actuaries made the first commercial use of the theory, and recent applications of probability and statistics have been made by biologists, economists, and agriculturalists.

During the war, however, probability went to work in the factories, and in no small measure was it responsible for the miracle of American war production. Today hundreds of plants in every field of industry have found statistical methods to be an indispensable tool of management and engineering science. Recent and continuing research in statistical engineering—much of it sponsored by Federal agencies—threatens to overthrow all accepted standards of industrial costs, operating efficiency, and quality of product.

No two things are ever identical. In a manufactured part, variation arises from many sources. The raw material may not be uniform. Dies chip, drills dull, wheels fall out of line. Workers differ in skill. They grow tired, careless. Temperature and humidity change. Gages wear out.

Generally, each individual item in a collection of similar parts will approximate in size, weight, hardness and other physical characteristics an ideal part whose dimensions are the average dimensions of all the individual parts. Presumably, this ideal part fits the specifications exactly. Engineers recognize the possibility of variation, however, by setting plus or minus limits known as tolerances for each important dimension.

In addition to getting the mean value of a dimension, the engineer also wants to have some measure of the variation. Since positive and negative deviations about the mean cancel out, the average deviation is always zero and is of no value for the purpose. Experience has shown that the square root of the average of of the squared deviations about the mean, the so-called standard deviation, is the best estimate of variation. Squaring eliminates negative numbers.

Normally only 46 measurements out of 1,000 will vary from the mean by more than twice the standard deviation, only 3 out of 1,000 by more than three times this amount.

This interesting property of the standard deviation is of the utmost importance to the industrial engineer. He uses it in obtaining and maintaining the quality of production, in setting up specifications and tolerance limits, in acceptance testing, in comparison of alternative materials and processes and in making performance studies of materials and machinery.

Like our Federal Government, industrial production has three functional divisions. Design and specifications are legislative, actual production executive, while inspection is judicial. In terms of working standards or tolerances, the designer sets them, the production engineer attempts to meet them and the inspector to enforce them. All are vital in the manufacture of the finished product and statistical methods have important but slightly different, application to each phase.

Tolerance specifications

With modern machines and equipment a product can be finished to almost any desired degree of perfection. In practice, however, there are two principal limiting factors. In the first place the intended use of the material or piece of machinery governs the degree of accuracy. Tolerances for the hinges of a barn door are far less severe than those for a watch spring. Cost is the second factor.

Dr. Walter A. Shewhart, engineer for the Bell Telephone laboratories and originator of statistical quality control, explains this. "It is not only what the engineer wants," he writes, "but what he can get, or at least get economically, that must be taken into account in the setting of tolerance limits."

An engineer trying to establish tolerance limits on a sound statistical basis must have some knowledge of the normal amount of variation to be expected. He obtains this either from previous experience or by test runs. Serious difficulties may arise when tolerances are set arbitrarily without regard for the actual variability.

As an example of what can happen, take the case of the initial specification for buoyant materials used in the Navy's kapok-jacket life preserver. A simple pad buoyancy test was used in which the buoyancies of the pads were measured after 24 hours' immersion in water. When the supply of pure Java kapok was cut off by war, it was necessary to mix stocks in this country with reclaimed material which had unknown, but inferior, buoyancy properties. To obtain minimum requirements, tests were run on several pads stuffed with various grades of mixed kapok. From such tests the average buoyancy was obtained but apparently the standard deviation was not calculated, or, if so, was not applied.

In any case the minimum buoyancy limit was set by arbitrarily subtracting 1 pound from the mean value.

The standard deviation of the test, determined later, was ¾ pound, which meant that in the neighborhood of 10 percent of the samples fell below the minimum. Since the acceptance regulations were very tight, almost every lot had to be rejected. Since the need for kapok was critical, the procurement regulations had to be waived altogether, until more realistic requirements could be developed.

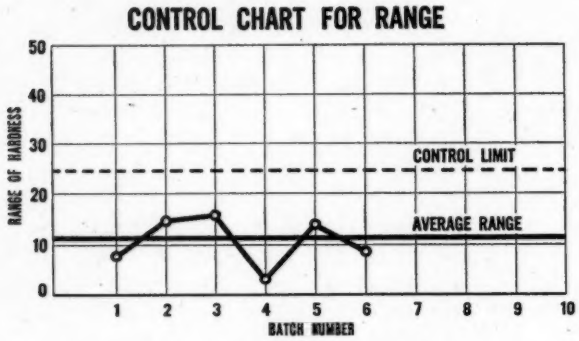
Once tolerances are set production can start, and at this point begins operation of the management technique known as statistical quality control. Although Dr. Shewhart got his idea back in 1924, production men considered it new-fangled and impractical, and with few exceptions it was not generally adopted. A brilliant exception occurred at the United States Army's Picatinny Arsenal, near Dover, N. J. In 1934 Lt. Leslie E. Simon (later Colonel Simon, head of the Ballistics Research Laboratory, Aberdeen, Md.) worked out with Shewhart, a highly successful control chart system for inspecting munitions.

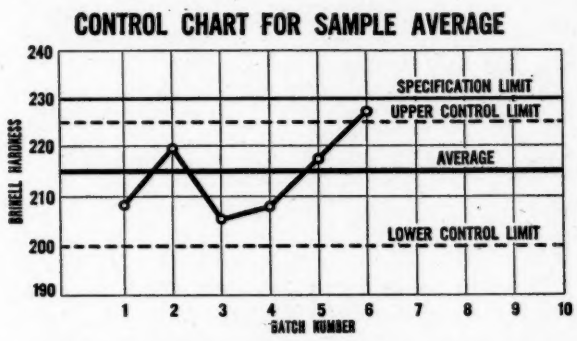
Quality control

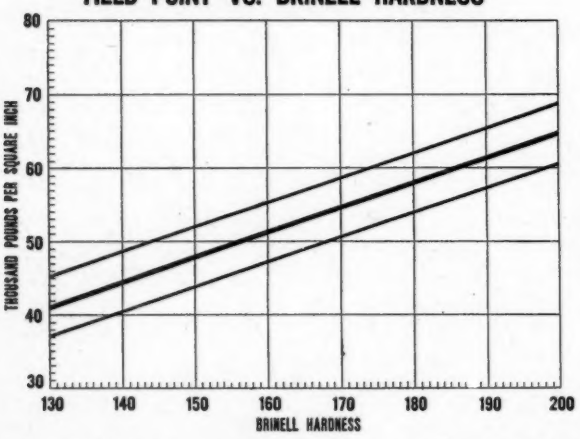
The basic Shewhart-Simon thesis is that quality must be built into a product; it cannot be inspected into it. Quality control methods can only indicate when and where trouble has occurred. Its identification and elimination becomes an engineering problem.

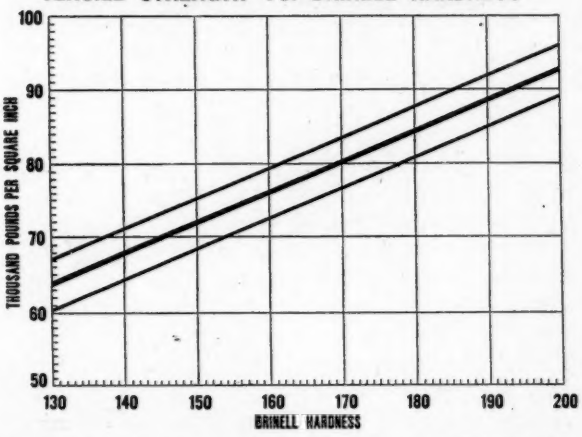
Under the Simon system each inspector is provided with two charts for every characteristic—size, weight, specific gravity—in which he is interested. Periodically he tests a sample, say, five pellets of powder each hour, from the output of each worker or machine. In testing for weight he finds the total weight of the pellets, divides by five and places a dot representing the average value on the control chart. Lines are drawn on the chart at points representing the tolerance limits. If the dot falls beyond these, the lot is immediately rejected.

In addition so-called control lines are drawn at points 3 times the standard deviation above and below









Quality control charts of Brinell hardness (above) and graphs showing relation between Brinell hardness, yield point and tensile strength. (Below:) In quality control, four samples are taken from each batch of material. The average hardness value is obtained and also the range between highest and lowest measurements. These values are plotted against batch number. Under the specifications the hardness must not exceed 230. The average hardness is 212 with a standard deviation of 4.75; the normal range in a group of four samples is 11 points.

Control limits for the average are set at three times the standard deviation, above and below the mean. If the average changes without affecting range, a drift in the process is indicated; i. e., change in atmospheric conditions, setup or raw materials. If range changes without affecting average, some local difficulty is indicated, such as nonuniform furnace temperature or poorly mixed material. The sixth lot is above control limit indicating that the process is out of control. Production should be stopped until the trouble is located and corrected. The center lines on the two graphs represent average values of yield point and tensile strength for given values of Brinell hardness. The limits of the bands are located at three times the standard deviation from the average. Since the bands are narrow, the relatively simple hardness test may replace the more complicated tensile and yield tests. Formerly, the Navy made a single tensile test for every 5,000 pounds of material offered. New specifications are based primarily on the hardness test, although tensile tests are still performed at less frequent intervals.

the mean value. We have seen above that normally only 3 dots in 1,000 will fall outside of these lines. When this occurs, therefore, it is a fair guess that something has gone wrong, either with the machine or the method of operation. The process is said to be out of control, and production is stopped until the trouble can be remedied.

With the outbreak of war the Army and Navy required incredibly close tolerances on many mass-produced items; for example 1/1000000-inch permissible variation in smoothness of certain bomb-sight bearings. One hundred, even five hundred-percent, inspection of the end product was unsatisfactory, to say nothing of the cost. Quality control sampling inspection at every essential point along the production line brought these accuracies within the realm of possibility.

Encouraged by the services, the civilian war production agencies urged adoption of statistical quality control for all types of production. In 1940 a Government-financed training program under the Office of Education began in colleges and technical schools, directed by such authorities as Stanford's Holbrook Working and W. Edwards Deming of the Census Bureau. During the 5 years over 8,000 industrial workers studied quality control under this program, averaging 57 hours per course. Thousands more received less technical training from their own companies. About 800 industrial establishments sent their top men, including vice presidents, chief engineers and chief inspectors, to intensive 8-day courses.

At present the Shewhart quality control technique is generally recognized as indispensable in attaining and maintaining quality and uniformity of production—whether the factor under control is tensile strength of wire, hardness of bearings or viscosity of ketchup. The total savings in manpower and materials made possible by these methods are impossible to estimate.

Acceptance sampling

The problem in acceptance testing by statistical sampling instead of 100-percent inspection, is two-fold. In the first place, there is the risk of accepting a lot which should be rejected. Secondly, there is the risk of rejecting a lot which should be accepted.

Risk is a probability term and is expressible numerically. For example, a 2-percent risk means that the unwanted event will occur 2 out of 100 times. The risk can theoretically be reduced to any point up to approximate certainty which is equivalent to the case of inspection sampling with 100-percent inspection. Of course, in destructive testing the sampling method must be used, so the problem becomes one of finding the most efficient method.

Also, before inspection can begin the inspector must have some definition of what constitutes an acceptable lot. This is given in terms of the maximum percentage of defective items which will be considered admissible in a lot containing a large number of items. For example, the acceptable quality level may be set at 5 percent. If more than 5 percent of the items are defective, it is desirable to reject the lot; if 5 percent or less, the lot should be accepted.

Of course it is impossible to distinguish sharply by any sampling plan between a lot containing exactly 5 percent defective and one containing just slightly over 5 percent. One hundred-percent inspection should be made to do this. By having the above information, as to what constitutes an acceptable lot, the mathematician is then prepared to find the size of the sample and the numerically acceptable criteria needed to be sure within the predetermined risks that an acceptable lot will actually be accepted and lots which are considerably worse will always be rejected. Instructions to the inspector are then prepared. In a typical case, if out of 25 items, no defective items are found, the lot is declared acceptable. If one defect is found, the test is continued to 35 items. If only one defect is found in 35 items, the lot is again considered acceptable. If in either case more than one defeective item is discovered, the lot is rejected.

The theoretical mathematics involved require a considerable knowledge of probability. However, actual determination of the sample size and acceptable number of defectives is easily found by formula. Moreover, tables—notably those prepared by H. F. Dodge and H. G. Romig of the Bell Telephone laboratories—are available which give the required numbers directly. A more complete set of tables was prepared during the war by the United States Navy but these are not yet generally available.

The Navy's sampling tables involve a novel and efficient method of acceptance sampling—sequential analysis—which was developed during the war by Abraham Wald, Columbia University, under a contract with the Applied Mathematics Panel of the Office of Scientific Research and Development. In this case the size of the sample is indeterminate. The method is particularly valuable in destructive tests since usually the sample size is about 50 percent smaller than necessary with fixed sampling methods.

Testing begins and the number of observed defects is tabulated along with the total number of items tested. This represents the sample size and for each size of sample an acceptance number and a rejection number is provided. Testing continues until the number of defective items for a given sample size reaches either the acceptance or rejection limit.

Not infrequently two or more physical characteristics of a product are so correlated that a knowledge of one permits the other to be determined. In the case of mass, volume and density the relation is exact. It is

No. of units inspected	Acceptance Number	Number of defects observed	Rejection number
1	--	0	--
2	--	0	--
3	--	0	--
4	--	1	4
5	--	1	4
6	--	2	4
7	--	3	5
8	--	3	5
9	--	3	5
10	--	3	5
11	--	3	5
12	--	4	6
13	--	4	6
14	0	5	6
15	0	5	6
16	0	5	6
17	0	6	7
18	0	6	7
19	0	6	7
20	1	7	7
21	1		7
22	1		7
23	1		8
24	1		8
25	2		8
26	2		8
27	2		8
28	2		9
29	2		9
30	3		9

The sequential method of acceptance sampling is illustrated by the chart above. In this method, developed by a federally sponsored wartime research group at Columbia University, sample size is not pre-determined. Usually a decision can be reached about the acceptability of the lot required in a sample of fixed size. This is particularly important when the test is destructive. At the time of inspection the form containing columns 1, 2, and 4 is prepared by the statistician, who considers such items as the risk of accepting a bad lot. The inspector keeps a cumulative total in column 3 of the number of defective pieces. As soon as this total matches either the acceptance or rejection number, testing stops and the appropriate action is taken. In the case shown, 7 defective pieces were found among the first 20 examined. Hence the lot was rejected.

unnecessary to run tests on all three quantities. At other times while the relation may not be exact, it may be sufficiently accurate to reduce the number of tests or to substitute simpler and less expensive tests for difficult and expensive ones. This is another common application of statistical analysis in the development of tests.

As an example, take the work done in the relationship between tensile and yield strength of metals and measures of hardness. This is of interest since the hardness test is rapid and nondestructive while a tension test is relatively slower and destructive.

An investigation into the relationship between Brinell hardness and tensile strength and yield point of high tensile steel was undertaken by the Navy Department during the war. The results are shown on page 8. The bands about the center lines are limits set by 3 times the standard deviations. In this instance for each value of Brinell hardness in only 3 cases in 1,000 would the tensile strength and yield point be expected to fall outside the bands.

Performance studies

Analysis of variance is a statistical method developed during the thirties in England by R. A. Fisher and his followers and in the United States by G. W. Snedecor at Iowa State College. It has proved remarkably successful in agricultural investigations but to date has been little used in engineering. By this method several factors influencing output or performance may be treated simultaneously and their relative effects estimated. In a typical study the importance of temperature, rainfall and various types of manurial treatment upon the yield of potatoes may be determined.

Many engineering problems were solved by variance analysis during the war by the statistical section of the Bureau of Ships. One of the most interesting was an investigation of serious piston ring wear on the main engines of a class of small aircraft carriers. The statisticians first drew up a data sheet to be used whenever an engine in one of several sample ships was to be pulled down. Data were collected on five positions of each ring, on the six rings of each piston, on the five pistons of each engine and on the two engines of each ship. The analysis of variance indicated that ship-to-ship variation was the most important source of variability. The position of the piston on the engine seemed to have little bearing on the wear, and the wear for all rings of a given piston was fairly uniform.

The ship-to-ship variability in ring wear suggested that piston wear was a function of the travel history of each ship—either the number of miles traveled or the speed of travel. This hypothesis was investigated by selecting a sample of 17 carriers to study ring wear under various service conditions. In the new study records were maintained on the number of miles steamed by each ship at various speeds.

The statisticians found that speed was far more important in causing ring wear than the total distance traveled before overhaul, probably due to a greater dilution of lubricating oil at higher speeds. On the basis of these conclusions the recommended rate of lubrication was adjusted in proportion to the volume of steam flowing through the cylinders rather than on the former basis of the area of the wiped surfaces. In other words, recommended lubrication is now roughly proportional to the cube of the shaft speed, whereas

previously it was directly proportional to the shaft speed. With this change in the method of lubrication, the problem of excessive ring wear was solved.

Analysis of variance can also be of great value in comparing different materials and processes. A typical experiment was designed for one naval laboratory to measure the effect of variation in carbon, manganese and titanium in high tensile titanium steel plate, and of carbon, manganese and vanadium in high tensile vanadium steel plate. Three levels of each chemical were to be used bringing the total number of specimens to 54. For this experiment all other components were to be held constant.

Another series of tests was developed to determine the effect of immersion in gasoline upon the buoyancy and seam strength of life preservers of various manufacturers. Still another test is currently under way to appraise the performance of ship-bottom paints.

The National Bureau of Standards is currently engaged in preparing mathematically sound plans for using these methods for comparative tests in rubber goods, textiles, steel alloys and other problems. As these problems are solved, a series of short, nonmathematical manuals will be prepared and issued explaining the methods used and how they can be applied to meet common industrial needs.

Reprinted from *Federal Science Progress*

Lemuel Shattuck, Statist
Founder of the American Statistical Association

by **WALTER F. WILLCOX**
Professor Emeritus, Cornell University

The most influential English and American workers in our field, William Farr and Lemuel Shattuck, together with perhaps the most influential American writer of prose and verse, Shattuck's fellow townsman and friend, Waldo Emerson, chose the older and shorter word, statist and eschewed the modern tongue-twisting statistician. Should not we lesser laborers in the same vineyard then revive their practice? Because I think we should, my title is "Lemuel Shattuck, Statist."

Childhood and youth

Lemuel Shattuck, the fifth among six children, was born at Ashby, Massachusetts, about 30 miles from Concord, the county seat, the bicentenary history of which was to be his first literary effort. In childhood and youth he had seldom more than 6 weeks of schooling in any one year and his formal education ended with two quarters in the local academy. Early in life he formed the habit of spending free moments during the day or time taken from sleep over substantial books or in self-directed study.

An influence which molded his youth may be guessed from the fact that his mother died when he was 4 years old, his father when he was 22, one sister when he was 23, and the other when he was 28, all of consumption. We may conjecture that the loss of four members of his family by a disease which even then was beginning to be thought preventable turned Shattuck's thoughts to sanitary problems as a major and in the end a dominating interest in his life.

The opening sentence of his diary—"This day 19 years ago I was born into this world a sinner possest of that principle which is opposed to God and his government; totally depraved in all my actions, desires and affections" is characteristic not only of Shattuck himself but also of the period before the frost had begun to loosen its grip on the soil of New England.

The sentence I have quoted was written just as the war of 1812 began. When it ended Shattuck joined the army of migrants westward, going first as a teacher to Troy and Albany where he was inducted into the latest educational fad, the Lancastrian System of Education. Later he ventured into the real wilderness under contract to teach this System in the primary department of an embryo institution in Detroit, the "Catholepistemiad or University of Michigania." It was based on a grant of $380 from the territorial legislature and burdened with a fantastic and jaw-breaking Greek nomenclature. In his 4-year venture at Detroit his health was impaired and his thin purse lightened because even the modest salary of $800 was not fully paid until long after his return.

Return to New England

Upon getting back to New England he drifted into the other great current of migration, that to the rapidly growing seaboard cities, and after 10 years in Concord moved first to Cambridge, five times as large, and soon after to Boston, where he remained until his death, 25 years later. Although Boston was only one-quarter the size of New York and three-quarters the

size of its other rivals, Baltimore and Philadelphia, it plumed itself upon being, with the support of Harvard, the intellectual capital of the Western Hemisphere and a modern Athens, with the *North American Review* rivaling the *Edinburgh*.

Shattuck as a bookseller and publisher, even on a modest scale, found himself at last in touch with the intellectual life of the world and soon built up a correspondence with many persons of like tastes with himself on both sides of the Atlantic. Being very systematic, if not pedantic, he constantly sought to systematize and so improve town, city, or State affairs. While on the Concord school committee, he had reorganized the public school system, prepared and printed school regulations, introduced school registers to be kept by teachers and filed as a part of their report, secured the passage of an ordinance requiring an annual report in writing from the school committee to the town meeting, and had written the first such school reports ever presented in Massachusetts. Other towns soon demanded the like and a few years later the legislature required them of school committees throughout the State.

Foundation of the A.S.A.

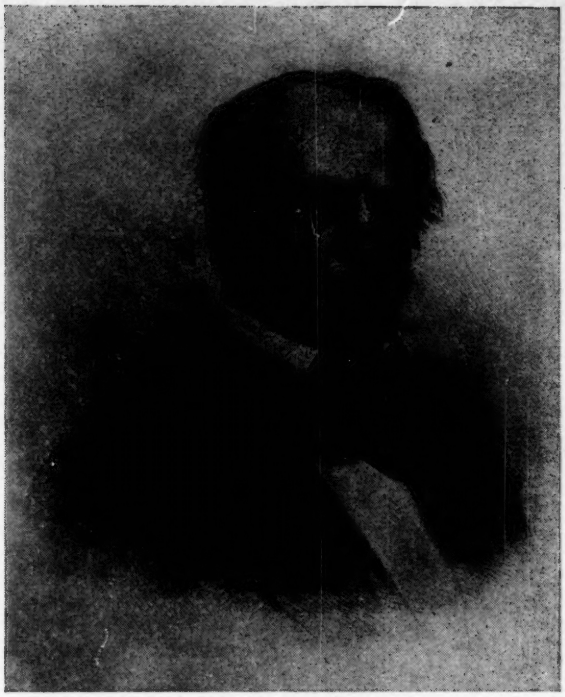
This sketch of Shattuck's life has reached the time when our Association was founded. In the preceding years a mushroom growth of statistical societies had sprouted in cities on both sides of the Atlantic but most of them soon withered. We may distinguish a French and a British group. The former included societies organized between 1827 and 1837 in 6 French cities; the latter societies organized between 1825 and 1838 in 11 British cities. During the same period 3 statistical societies sprang up in the western hemisphere, the Mexican National Institute for Geography and Statistics with its germ in Madrid, the New York Statistical Society, and the American Statistical Association, of which only the last developed a vigorous life.

Our own Association originated beyond a doubt in the example of the British group of societies, particularly the Statistical Society of London. But seemingly the founders thought it unwise to stress that fact. The memory of two recent wars against England, reenforced by the swelling stream of bitterly anti-British immigrants from Ireland may account for this reticence.

Campaign for vital statistics

Little more than year after our Society was organized the Massachusetts legislature received two memorials, one from the American Academy of Arts and Sciences, the other from the Massachusetts Medical Society, but both due to Shattuck's initiative, urging the enactment of a law for the effective registration of births, marriages, and deaths.

This study did not result in effective action but



LEMUEL SHATTUCK

shows an acquaintance unusual for a century ago with sound demographic methods and the best foreign authorities; at the time there were no American authorities.

In 1843, luckily, Shattuck was elected to the Legislature and became chairman of a joint committee "to consider the expediency of modifying the existing laws relating to the registration of births, marriages, and deaths." Before the session closed the bill was passed and the campaign which had begun 11 years before ended at last in victory. In the 10 years following the enactment of the first of these laws New York, New Jersey, Connecticut, New Hampshire, Kentucky, and Pennsylvania passed similar measures and other States followed but more slowly until by 1933 every State had fallen into line, and the country had developed a unique and effective system of registration statistics based upon voluntary cooperation between the constituent States and the Federal Government. For our present country-wide registration system Shattuck deserves more credit than any other man.

A census of Boston in 1845

Before this campaign ended he turned his attention to the other pier on which the arch of demography rests by moving to improve census practice in Massachusetts. Serious errors had been detected by Jarvis

in the 1840 figures for Massachusetts and by Shattuck in the 1840 figures for Boston. Using this evidence of weakness as an effective lever Shattuck induced the Boston City Council, of which he had recently been a member, to set up a joint committee "with full powers to procure a census of the city of Boston with such other statistics as they may deem proper." This committee engaged Shattuck for the task, and eight months later he presented the results in the form of a "Census of Boston for the Year 1845," the pioneer among modern American censuses.

Giving a line on the schedule to each person instead of to each family, Shattuck made the person the census unit, facilitated recording the name, age, birthplace, marital condition, and occupation of each person, and allowed the preparation of many new and important census tables. Shattuck also introduced collateral material from official sources and bound the whole together through a critical interpretation of the results. Because of this outstanding success he was called to Washington for advice when the Federal census of 1850 was at hand. There he drafted five of its six schedules and wrote the enumerators' instructions; in fact the United States census of 1850 was the Boston census of 1845 writ large. The most important improvements during 150 years of Federal censuses resulted from the adoption in 1850 of Shattuck's ideas.

Campaign for sanitary survey

His last and probably his greatest social service was as chairman of a commission to suggest a plan for a sanitary survey of Massachusetts. Its "Report," written entirely by him, proved to be a milestone in the improvement of American public health. Shattuck proposed to set up a State Board of Health which, like the State Board of Education, should lead in the effort for improvement. For 20 years his report lay almost unnoticed but in 1869, after the political and military struggle over slavery and secession had ended, Massachusetts reverted to his ideas and established the earliest American State Board of Health. Of this report George C. Whipple wrote two generations after it appeared: "One is amazed, first, at the farsightedness of Shattuck, and, second, at the way in which his ideal slowly fulfilled itself; there is hardly one of his 50 recommendations which has not in one way or another been carried out in Massachusetts, and there is hardly a public health measure put into practice which was not anticipated by Shattuck, save only those relating to bacteriology—a science then unborn."

Shattuck, the statist

The evidence thus outlined seems to warrant these conclusions:

Shattuck was the leader in founding the American Statistical Association.

He was the main agent in carrying to a successful conclusion the prolonged campaign for that effective system of registering births, marriages, and deaths in Massachusetts, which has now expanded to include every State in the Union.

Through his influence and that of his Boston census of 1845 upon the Federal census of 1850, the census practice of the United States was modernized.

Through his Plan for a Sanitary Survey of Massachusetts to be executed by a projected State Board of Health, he contributed more than any man of his generation, professional or lay, to the improvement of American public health and preventive medicine. Such a State Board of Health was established in Massachusetts 20 years after his report recommended it and then imitated in State after State.

Through the 50 recommendations embodied in that Plan he anticipated nearly all the public health measures not based on bacteriology which were introduced in the following two generations.

Because of these achievements he stands out as the most influential American statist.

(From the longer version published in the *Journal of the American Statistical Association*, Volume 35, No. 209, Part II, p. 224.)

New High-Speed Computing Devices

by FRANZ L. ALT
Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

The outbreak of the last war created an enormous demand for research work in all fields of science, most of which had to be completed at the earliest possible time. This in turn brought about a huge volume of computations which had to be carried out in order to assist scientists in their work. Whatever computing equipment was available at the beginning of the war—desk type computers, punch card machines and even the most advanced device at the time, the Bush Differential Analyzer—was soon loaded up to capacity with computational problems, and along with them an army of human computers strove to accomplish its task. Faced with this situation the Ordnance Department sponsored the development of several high speed computing devices for the Ballistic Research Laboratories at the Aberdeen Proving Ground.

It was realized early in the program that the development of digital machines was more promising than that of continuous-variable devices. Moreover, it was felt that entirely new methods for storing and handling numbers were called for. Thus, the approach selected differed from that of the Massachusetts Institute of Technology, which modernized its differential analyzer and made it into the best continuous-variable machine now in existence, and from that of the International Business Machines Corporation whose Automatic Sequence-Controlled Calculator at Harvard, although unprecedented in size, was based for the most part on the application of existing computing techniques. Instead, two entirely new principles of computation were developed under the auspices of the Ballistic Research Laboratories.

The ENIAC (electronic numerical integrator and computer)

The first of these was the use of vacuum tubes for computation. The result of this development was construction of the ENIAC which was undertaken by the Moore School of Electrical Engineering in Philadelphia and was completed in the fall of 1945.

The ENIAC represents numbers by rows of vacuum tubes. For instance, a single digit between zero and nine is represented by 10 vacuum tubes of which exactly one is "on" (i.e., in its conductive stage), while the others are "off." The value of a digit determines which of the 10 tubes is "on" at any time. Tubes are electrically connected in such a way that numbers can be manipulated. For instance, in order to add the number one to a digit, a single electric pulse is sent through the 10 tubes which represent the digit. The wiring is such that the occurrence of such a pulse will extinguish the tube which had previously been operated, and will instead operate the next tube in the row. By sending pulses repeatedly, other numbers can be added.

Actually, the description given so far over-simplifies the construction of the machine somewhat. In addition to the ten tubes mentioned, there is another set of ten which are the opposite of the first set, i.e., they are all conductive with the exception of the one corresponding to the single conductive tube of the first set.

The great advantage of the scheme lies in the fact that vacuum tubes will respond to very high pulse rates—100,000 per second or more. Computation can thus be carried out extremely fast. Millions of multiplications, for example, can be performed in an hour.

In order to perform a given sequence of computation, the proper connections have to be established between the components of the machine. This is accomplished by setting numerous switches and plugging wires. It requires a great deal of time and risks of errors. These must be eliminated by running test problems of which the answers are known in advance. For these reasons it is efficient to change problems on the machine at infrequent intervals. Once the set-up of a problem is accomplished and tested, numerous problems of the same kind can be solved very quickly, several hundred times faster than by hand.

In the past year the ENIAC has been used successfully in the solution of numerous ordinary differential equations, of partial differential equations in two variables, evaluation of integrals, smoothing of functions and various other problems.

The Bell Telephone Laboratories machine

Simultaneously with the construction of the ENIAC, another machine was developed for the Ballistic Research Laboratories by the Bell Telephone Laboratories in New York. Where the ENIAC uses vacuum tubes to represent numbers, the latter machine uses relays of the same kind as are used in telephone exchanges. The idea of using relays for computation is due to George R. Stibitz, and the machine built at the Bell Telephone Laboratories is sometimes briefly called the Stibitz machine. It is easy to see that relays can be electrically connected to represent and manipulate numbers in the same way as was done with vacuum tubes in the ENIAC. In fact, the use of relays brings with it a number of simplifications as compared with tubes. On the other hand, the rate of operation of re-

lays is slower than that of vacuum tubes by several orders of magnitude.

As a result the Stibitz machine is relatively slow. It performs a multiplication in approximately a second. On the other hand, it is a great deal more flexible than the ENIAC. Since relay circuits can be designed more efficiently and with greater complexity than electronic circuits, the Stibitz machine is able to perform very complicated operations. As in most digital machines, the basic operations which the machine performs are only those of addition, subtraction, multiplication, division, and extractions of square roots. But the machine can be instructed in advance to perform a long sequence of such operations.

It can also be instructed to choose between alternative courses of action. Some of the most frequent, but by no means the most complicated, choices which the machine will perform, are these:

In a problem solved by successive approximation, the machine repeats the iterative process until the difference between two successive approximations is smaller than a predetermined limit. When this condition is reached, the machine discontinues the iterations, prints the answers obtained and automatically starts computation on the next problem.

In the numerical integration of differential equations by some step-by-step method, the machine will automatically select the most favorable length of the integration step. It can be set up to use any of the customary criteria for determining this optimum; i.e., the magnitude of some derivative, or the number of iterations required for each step.

The machine is designed to operate at night without requiring the presence of a human operator. If, during unattended hours, a trouble occurs— this may be either a failure of some part of the machine or an error of the operator who had previously set the machine up for a particular problem—the machine will wait a short time to see if the trouble clears up and will then automatically discontinue all computations on the present problem, and immediately start work on any other problem that has been prepared for it.

Among the problems which have been successfully solved on this machine are the integration of ordinary differential equations, partial differential equations in two variables, systems of simultaneous linear equations (this is especially profitable on this machine), quadratures, evaluation of functions by means of power series, Fourier series, or recursion formulae.

The EDVAC (electronic discrete-variable computer)

Even before the ENIAC and the Stibitz machine were completed, it was realized that the advantages of both machines could be combined and that additional advantages could be obtained in the construction of a computing machine which had not been anticipated at the time when the development of the earlier machines was first contemplated. This led to the plan of the development of still another type of computing machine which has become known under the name of EDVAC. This machine is now being developed by the Moore School of Electrical Engineering for the Ballistic Research Laboratories. It will use vacuum tubes as its primary elements, and will thereby obtain approximately the same speed of computation as the ENIAC. The setting-up of programs will be similar in some respects to that of the Stibitz machine, and will thereby insure the same flexibility; in some respects there is expected to be even more flexibility than in the latter. Most important of all, this machine will be capable of storing hundreds of numbers which may be obtained as intermediate results in the course of a computation, and which are almost instantaneously accessible for future computation. The lack of facilities for intermediate number storage has been recognized as one of the major drawbacks of existing machines. The ENIAC has a storage capacity of 20 numbers. The Stibitz machine stores 30 to which it has immediate access, and can in addition perforate about 2000 numbers on a paper tape from which they can be read off by the machine itself. In the latter form of storage, however, considerable time is required to find any desired number on the tape; in some problems this time runs as high as several hours. The EDVAC, on the other hand, has immediate access to several hundred numbers (the exact limit depends on the nature of the problem) and has additional facilities for more storage on tape which will be accessible considerably faster than in the Stibitz machine.

The availability of these machines will enable us to solve problems which have hitherto been inaccessible to numerical methods. It is believed that partial differential equations in three or four variables, integral equations, and problems in the calculus of variations are within the scope of the EDVAC. (This statement refers, of course, to problems which admit no analytic solution and which have to be attacked by numerical methods.) Large systems of simultaneous algebraic equations, e.g., systems of hundreds of linear equations, can likewise be solved on the EDVAC. The possibility of solving these problems is of incalculable importance to scientists and engineers and opens new paths in all the sciences.

A Well-Rounded Curriculum in Statistics

by WILLIAM A. NEISWANGER
H. K. ALLEN
University of Illinois

A mere statement of our problem—the content of a well-rounded curriculum in statistics—immediately raises a number of questions on which statisticians differ. For example, can the curricular question be considered in the abstract or is it necessary to use adjectives to makes the question read: a well-rounded curriculum in economic statistics, or a well-rounded curriculum in mathematical statistics or psychological, industrial, agricultural, or business statistics?

Types of statisticians

The author of a recent letter published in the *Journal* of the ASA (Dec. 1946, p. 621–2) attempts to sort the major interest groups in the field of statistics into three classes: the *mathematical statistician,* whose primary interest is the theory of statistics; the *operating statistician,* who applies statistical principles and techniques to the solution of current problems of government and business; third, the *subject-matter specialist,* to whom statistics is a tool subordinate to his major interest.

Certainly one cannot define a well-rounded curriculum in statistics until he faces some of the issues raised by this classification. If one chooses the first "frame of reference," that of statistical theory, to the exclusion of application and subject matter, then conceivably one can outline a curriculum without reference to the field in which the student will ultimately apply the techniques. The curriculum, the courses, and the analysis will all move at a level of abstraction consistent with the Betas, the Sigmas, the Gammas, the T's and Z's and P's used to symbolize the process.

Such a curriculum would be organized in the department of mathematics and would attract those students who are interested in the abstractions of theory. Graduates of such a course of study, should find a useful place in large enterprise, either governmental or industrial, as consultants on special problems and on methodology in the pioneering stage.

A Bureau of Business Research occasionally has need for the highly specialized training of the mathematical statistician and is fortunate if there is such a person to call in as a consultant, from time to time, from the mathematics department of the same educational institution.

The bulk of the responsible statistical work in the Bureau of Business Research, however, is in the applied field of economics and business and the techniques commonly employed are the more or less tried and proved methods of analysis which have shown their peculiar usefulness in these fields. This condition is also present in most economic and business research organizations wherever they are found.

A statistician in the Bureau of Business Research, or similar agency, therefore, falls in the second classification—he is an operating statistician in a reasonably well-defined and specialized subject-matter field.

The well-rounded curriculum we would discuss, therefore, is oriented around the instructional needs of the statistical worker who carries the load of analysis in these applied fields. The nature of our obligations to other students in a department of economics or school of business also require that we take this point of view. For it is our continuing task to train personnel who can enter economic, marketing and business research, in an operating position immediately after completing the work of the bachelor's degree. Providing the training which makes this possible is, we believe, an important and useful function of higher education although the products of such a four-year course of study, which also satisfies the numerous requirements of the bachelor's degree, will not be statisticians of a high order of specialization. Graduate work is required for that, or so it seems to us.

We conclude, therefore, that the well-rounded curriculum in statistics which we would recommend cannot be drawn up in the abstract. Adjectives must be used to define it, and we have narrowed the problem as follows: A well-rounded curriculum in economic and business statistics for the undergraduate student.

Statisticians solve specific problems

The individual we have in mind needs to be trained in theoretical statistics—that is, mathematics. A worker whose training has been too much in the applied side is often helpless before a formula which needs slight modification to suit a particular case met in operations. Further, there is always a danger that he will misapply the mathematical analysis because he does not understand the assumptions which underlie the devices he would use.

We also believe, however, that the operating statistician needs training in the subject-matter field in which he will carry on his operations. We are convinced of this because, as supervisors of statistical workers, we have seen individuals with exclusively

theoretical training stand helpless before practical problems, totally unable to take hold and progress with them. Further, there is danger that, although he may understand the limitations of the theoretical mathematical procedures, he will not comprehend the basic nature of the data before him. Thus he may make errors in the application of the mathematical devices which are as serious as those made by workers who lack the grounding in mathematical theory.

Theory is important in all phases of statistical methodology, but in certain highly important areas of statistical analysis it is economic theory rather than mathematical theory which is significant. The analysis of time series and the construction of index numbers are essentially economic problems rather than mathematical ones. We incline to the view that an awareness of the connections in the economic process contributes greatly to the statistical analysis of economic time series, and the construction of an index number must be oriented around the question which it is desired the index number should answer. Here, we are in the field of public and business policy rather than of mathematical theory.

Statisticians must reason mathematically

Lest we be misunderstood at this point, however, please recall that we have already declared in favor of training in theoretical statistics. The well-rounded curriculum would contain, and students seeking statistical training would be required to take, a number of courses in mathematics. Under our new curriculum at the University of Illinois, for example, any one wishing to specialize in statistics in the economics department of the College of Commerce is required to take mathematics through calculus. If he comes to us as a junior with only algebra, he is to be required to take a course entitled "Mathematics for Statistics," based on such a book as Peters and Van Voorhis, *Statistical Procedures and Their Mathematical Bases.* In addition to these courses, all given by the mathematics department, he must take another course in that department entitled "Elementary Probabilities and Sampling Theory." Further, he is to be encouraged though not required to elect additional courses such as the theory of probability and sequential analysis.

Our purpose in requiring these courses is not only to see that the student gains some proficiency in the manipulation of mathematical formulas, and the ability to undestand the symbolism, but to be sure that he comprehends the rigorous assumption made in the logic of the mathematical analysis and hence, the limited situations in which the techniques can be applied. There, as in other courses we recommend he should "get the feel" of the subject which every good statistician has, although he would be at a loss to explain in what course or in what series of courses it came to him. After this required work in mathematics, our student would scarcely qualify as a statistical theorist, but he should be reasonably well at home in the theory of statistics.

Mastery of the applied field

Then, if our student is to work in a Bureau of Business Research, or in some other applied field, as we have assumed, we think that he should have a number of courses in the applied field, not only in applied statistical methods but in so-called subject-matter fields as well.

We are firmly of the opinion that some two years should be spent on statistical methods in the applied field and in closely related subjects. Here, we presume, is where we part company with one school of thought.

We think that not less than two semesters should be spent on statistical methods, narrowly defined, in the applied field. The second semester, at least, should be at the junior level and requirements should be such that, at the end of the year's work, the student should be proficient in the methods contained in the more advanced textbooks in that subject-matter field.

We have a number of reasons for insisting on a study of methodology in the applied field. First, statistics courses as usually given in mathematics departments omit large segments of material which are important from the point of view of the subject-matter field. For example, the practical problem of laying out a sample, problems of definition, editing of data, questionnaire construction, tabular presentation, graphics, time series analysis, and index number construction, all of which are essential in the analysis of economic and business statistics. Second, the student should become familiar with the statistical peculiarities of the data in the applied field, including their sources and their characteristic behavior, and the particular statistical devices which should be used in the analytical situations which are apt to be met. Third, the suitability of the classical methods of statistical analysis in any subject-matter field and the limitations of them can best be taught in that field. For example, is one ever justified in correlating time series, and if so under what conditions? In variance analysis is it possible to assume, when accrual data are used, that the residual variation is random? Is it possible to apply sampling theory in interpreting the statistical constants derived from data which are ordered in time? What, for example, is the concept of the parent population when production of a given commodity covering a span of years is analyzed? Fourth, the student needs training in searching of records, in establishing his statistical units, in compiling his own homogenous series, in analyzing the realistic data, in considering the extent to which the actual conditions meet the requirements of the abstract methods of theory, in analyzing the limitations both of the method and of the results, and finally, in preparing a well-documented report. This

training is necessary if the student is to make the transition from pure theory to the analysis of real situations and is equally important in other phases of his preparation.

By the time this work is completed in the applied field, the student will have been through the conventional work dealing with the collection and editing of realistic data in his own field of specialization; analysis of the frequency distribution; averages; including an examination of the special situations often met in the field of calling for the use of certain averages; measures of dispersion, index numbers, trend analysis, including various exponentials and modifications of them; correlation, linear, curvilinear multiple, and partial. Also, he will be introduced to the fields of sampling, estimation, and inference. He will deal with large and small, simple and stratified, random samples; and the analysis of variance will doubtless have let a lasting imprint on his thought processes as he is led to realize that differences among the classified traits are important only if they are large with respect to the variation within the several classes.

The statistician in economic research

Following this year of work in the applied field, we recommend for the student who would work in a Bureau of Economic and Business Research, or on similar assignments, a course which may be called, as it is in some institutions, "Inductive Economics," or alternatively, "Statistical Economics." This course will take the student to the literature in which attempts have been made to broaden the domain of knowledge by the use of statistical methods applied to quantitative economic data. Published studies of the behavior of prices, measurement of and trends in production, productivity of labor, capital information, and national income would be studied. Also there are many interesting methods of measuring the cyclical component in economic series which should be passed in review. Some additional contribution to the students' knowledge of methodology will be made in this course. The analysis of price behavior has led to the use of the Pearsonian family of curves as the frequency distributions are analyzed, and sinusoidal analysis will be met in some of the studies of cyclical variations, to mention but two extensions of method which would be made. The work of Mills, Burns, Crum, Kuznets, Gilbert, and Tinbergen suggest the type of literature we have in mind.

Coupled with the study of the literature of inductive economics, we recommend special projects which will acquaint the students with basic source materials in the field of his special interest.

While the work of this course progresses, the student will be concurrently enrolled in one or more specified mathematics courses, as we have suggested, so that the methods used by the authorities in the applied field may be examined in light of the pure theory of statistics.

Statistics for a business career

If, instead of planning for a career in economic research the student is preparing for an active career in business, we would recommend a somewhat different type of course to follow the year's work in method in the applied field. This course we would call "Statistics for Management," or "Statistics for Internal Control," and we think it should be available in a well-rounded statistics curriculum in the field of economics and business. First emphasis would be on methods of making shortrun estimates or forecasts, as these are especially related to problems of budgeting, financial, sales and production. Attention would also be given to the analysis of demand, possibly of both the Henry Schultz variety and the market research type. There is a literature on the analysis of demand, of course, in which the names of Moore, Schultz, Roos, Ezekiel and various writers on market research are prominent. On short-run estimating there is little literature, and the materials of the course would have to be collected from business experience. Unfortunately, we are unable to write the specifications for this course in any detail because we are not now offering it—we do not know of any such course being offered—but we consider it to be an important area in the applied field which should be opened in a well-rounded curriculum. Several methods of statistical analysis new to the student would be examined in this course too.Possibly the estimating techniques developed in the Westinghouse organization are worthy of attention. Problems of passing from dynamics to statics in economic analysis by the Schultz methods present new issues, and the special uses of correlation and index-number techniques in demand analysis will make further contribution to the students' technical skills. Possibly the subject matter included here should be divided into two courses, one of which would deal exclusively with market research.

In the senior year, as a capstone course, both for researchers of the type needed in the Bureau of Business Research and for those looking to a career in business, we recommend a course in business cycles. Here we would consider both inductive and theoretical materials. For the undergraduates the theoretical part of the work can well be based on such a study as Haberler's *Prosperity and Depression.* On the inductive side we would use a range of material with principal emphasis on National Bureau of Economic Research publications.

The well-rounded curriculum

The well-rounded curriculum in statistics would include them, as we see it, not less than two years' work in mathematics and a minimum of two years' in the applied field as we have outlined it. This would give

a total of some 26 hours. The other hours required for the bachelor's degree could include some additional work in statistics in other colleges of the University, such as Quality Control, in the Engineering College; or agricultural price analysis in the College of Agriculture. In addition, subject-matter courses such as Economic Theory, Money and Banking, Labor Economics, Taxation, Marketing, and so on, would be taken to give the student a specialized subject matter field in which his statistical methods could then be efficiently applied. Required courses in rhetoric, report writing, and similar subjects will make their contributions.

A student who followed such a course of study at the University of Illinois would receive his degree in Economics or Commerce, with a specialization in statistics.

Those of you who are familiar with the lock-step-close-order congestion which exists in most university curricula understand that such revisions in curricula cannot be made as quickly as one might wish.

Anyone who has been responsible for the work of a research organization knows that in addition to the technical skills a statistical worker attains only as a result of long and careful study, there are also required those highly important traits of accuracy, patience, strict intellectual honesty, self-criticism, and the ability to write an understandable and well-documented report. Some of these traits good statistical training produces; some are developed in rhetoric courses which are part of the required work in any college curriculum; but others of these traits come only as a result of a total experience, in which early training, moral discipline, and a complex of environmental conditions make the difference.

We believe that the program of undergraduate study which we have recommended is well-rounded and well-balanced. Under competent supervision in a working research assignment, individuals with such training should develop until they are welcome in the society of statisticians. Upon completion of their studies they should be able to carry their share of the load in operating positions of considerable responsibility.

CHAPTER NOTES

ALBANY

The following officers were elected on June 18, 1947: Davis L. Shultes, President; Ethel E. Metzendorf, Vice President; Max Weinstein, Secretary-Treasurer; Directors, William Blair, Murray Dorkin.

CENTRAL NEW JERSEY

The final meeting of the season was held on June 4 at Princeton University and was addressed by Professor John W. Tukey on the subject of "The Uses and Usefulness of Binomial Probability Paper."

Professor Tukey demonstrated the new type of graph paper designed in collaboration with Dr. Frederick Mosteller of the Department of Psychology, Harvard University. They used an earlier mathematical treatment of the subject by R. A. Fisher as a basis for the cross-hatched paper, which is now available from the Codex Book Co. A detailed description of the new paper will appear in an early issue of *The American Statistician*.

Revision of Article VII of the Constitution was approved by a majority of the members through the medium of mail ballots, to permit wider discretion in the choice of the annual meeting date. The dues of the Chapter were increased to $1 a year.

The slate of officers elected for the coming year was: President — J. Stevens Stock, Opinion Research Corporation; Vice President — F. F. Stephan, Princeton University; Secretary-Treasurer — William Netschert, Jr., N. J. Unemployment Compensation Commission; Assistant Secretary-Treasurer — Mary McKallen, N. J. Unemployment Compensation Commission; District Representative — John W. Tukey.

CHICAGO FORECASTS BUSINESS OUTLOOK

by **WALTER E. HOADLEY, Jr.**
Federal Reserve Bank of Chicago

For some years it has been customary for the Chicago Chapter to devote one meeting each year to a discussion of the business outlook. Although the programs have taken different forms, they have all been designed to reflect both the views of informed business analysts and the forecasting methods which they employ.

As part of the June 1947 business outlook meeting, the entire Chapter membership for the first time was asked to participate. Each member was invited to make his own forecast of the probable trend of four well-known and widely used measures of business activity during the fourth quarter of 1947 and the second quarter of 1948. The four measures were: (1) gross national product (U. S. Department of Commerce), (2) unemployment (U. S. Bureau of the Census), (3) industrial production (Board of Governors of the Federal Reserve System), and (4) wholesale prices (U. S. Bureau of Labor Statistics). Choice of these specific series, of course, does not preclude the use of a different set in future surveys.

To assist in making the forecasts, appropriate back data for each of the series and their principal components were supplied to each member two weeks before the meeting. A tabulation summary of the individual estimates was made and distributed to each member at the meeting, giving the arithmetic mean, standard deviation, and general frequency distribution of the forecasts.

Although no individual estimates were identified either in the summary tabulation or in the discussion of the findings at the meeting, members were requested to give their names with their estimates in order that the persons whose forecasts prove to be most nearly correct can be identified later. As the actual data for these four measures of business activity become available against which to measure the individual forecasts, the names of the best forecasters will be announced. These individuals will then be asked to present at a Chapter meeting the general method which they used in making their estimates.

In spite of the fact that forecasting is everywhere conceded to be an essential part of business and Government practice, many statisticians are reluctant to make forecasts. However, over fifty forecasts were submitted by Chapter members and the forecast poll seems likely to become an integral part of the business outlook meetings of the Chicago Chapter in future years.

On the whole, participants in the business forecast poll are optimistic about short-run prospects. The general belief appears to be that a gradual downturn in business is in the offing, but that whatever recession lies ahead probably will be moderate. Gross national products of $203 billion during the fourth quarter of 1947 and of $192 billion during the second quarter of 1948 are foreseen. The number of unemployed persons is expected to rise to 3.5 million in the final quarter of 1947 and further to 4.3 million during April–June of next year. The Federal Reserve Board industrial production index is expected to move gradually downward to 185 by the fourth quarter of 1947 and to 176 in the second quarter of 1948. Greatest pessimism is found in the price sector, with an anticipated drop in the BLS index to 140 during October–December and to 132 during the second quarter of next year. A number of questions about the consistency of these composite average forecasts have been raised and the findings are being studied to develop this point further. As would be expected, the magnitude of the standard deviations was nearly half again as great in the case of the forecasts for the second quarter of 1948 as for those covering the fourth quarter of this year.

The findings of this Chapter poll were presented by Walter E. Hoadley, Jr. of the Federal Reserve Bank of Chicago, who served as moderator at a panel held by the Chapter to discuss the business outlook. As a panel participant, John Parrish, Chicago Re-

FORECASTS OF BUSINESS INDEXES

AVERAGES OF 48 CHICAGO CHAPTER MEMBERS' FORECASTS

Business Index	*4th Quarter 1947*		*2nd Quarter 1948*	
	Index	*Std Dev.*	*Index*	*Std Dev.*
Gross National Product (*Billion Dollars*)	203.3	±*14.9*	191.7	±*19.8*
Unemployment (*Million Men*)	3.55	± *1.03*	4.28	± *1.34*
Industrial Production (*Percentage of 1935–39 Average*)	184.6	±*14.1*	176.1	±*21.0*
Wholesale Prices (*Percentage of 1926 Average*)	139.7	±*10.8*	132.2	±*13.8*

gional Director, U. S. Bureau of Labor Statistics, analyzed each of the major possibilities for short-run price movements and concluded that a gradual downturn lies ahead. Justin F. Barbour, president of Barbour's Dow Theory Service, Inc., discussed the relationship between the movement of the security averages and general business trends, developing his belief that a bear market will continue for some time. Kenneth Arrow, Research Associate of the Cowles Commission, University of Chicago, illustrated the econometric approach to business forecasting in presenting his views that a moderate decline in business was in prospect.

ELECTIONS AND SPEAKERS

Howard L. Jones is to serve as District Representative for the coming year, and the slate of officers elected on June 18 is: President—Walter E. Hoadley, Jr., Federal Reserve Bank of Chicago; Vice-President (and Program Chairman)—George A. Morgan, Peoples Gas Light and Coke Co.; Vice-President (and Membership Chairman)—Milburn L. Forth, Commonwealth Edison Co.; Secretary—De Ver Sholes, Chicago Assn. of Commerce and Industry; Treasurer—George R. Hays, Illinois Bell Telephone Co.; Directors: Guenther Baumgart, Chicago Assn. of Commerce and Industry; Frank P. Breckinridge, Breckinridge & Co.; Jacob Marschak, University of Chicago; and Kenneth E. Miller, Armour and Co.

The Chapter's Committee of Government Statisticians met on May 21 for a panel discussion on "Problems of Practical Use of Government Statistics." The panel speakers were Guenther Baumgart, Chicago Association of Commerce and Industry; George R. Hays, Illinois Bell Telephone Co.; Walter E. Hoadley, Federal Reserve Bank; John Madigan, Booth Fisheries.

Dr. E. C. Young of Purdue University addressed a dinner meeting of the Chapter on "The Effect of Technological Developments on Agriculture during the Decade Ahead," on May 22.

CINCINNATI

Five meetings were held during the past winter: Procter Thomson of Procter & Gamble Co. spoke on "Sequential Analysis of Statistical Data"; Dr. Paul Herget of the University of Cincinnati on "Recent Scientific Computing"; Victor Cooper of the Cincinnati Gas & Electric Co. on "Analysis of Electric Loads"; Walter A. Baude of the University of Cincinnati on "Experience of a Finance Officer in the Mediterranean Theatre of Operations"; and Dr. P. K. Whelpton of the Scripps Foundation for Population Research on "Revised Population Rates in the U. S."

The Chapter elected the following officers for the coming year: President—Walter A. Baude, University of Cincinnati; Vice President—Victor Cooper, Cincinnati Gas & Electric Co.; Secretary-Treasurer—Lee M. Welsh, Procter & Gamble Co.

The next meeting on September 16 will be the annual exchange of opinions regarding the levels of industrial production for the balance of 1947 and the year 1948. As usual there will be comments on business in general.

CLEVELAND

The twenty-second annual meeting of the Cleveland Chapter was held on May 27. The slate of officers for 1947–1948 was elected unanimously: President—E. A. Stephen, The Ohio Bell Telephone Company; Vice President—Cleveland Federal Reserve Bank; Secretary—Gale R. Ober.

Mr. F. D. Newbury, a member of the Board of Directors of the Westinghouse Electric Corporation, spoke on "What's Ahead for Business." A high level of business activity for the next twelve months, with "no need for any repeat performance of the 1920–1921 recession" was forecast by Mr. Newbury.

COLUMBUS

The following officers were elected by the Columbus Chapter for the year 1947–1948: President—Alva M. Tuttle; First Vice President—Virgil H. Dassel; Second Vice President—Rosemary Tague; Secretary Treasurer—Mikhail Condoide.

DENVER

The Denver Chapter concluded its winter program on May 8. The outgoing President, E. H. Cramer of the Denver office of BLS was designated District Representative. He reports that: "We have had a very successful year. Attendance at our meetings varied between 34 and 41, with an unweighted average attendance of 36.875 approximately."

DETROIT

The Chapter concluded the season's program with a meeting on May 20 addressed by Rensis Likert, Director of the Survey Research Center of the University of Michigan. Dr. Likert spoke on the philosophy and procedures used in connection with the Liquid Assets and War Bond Surveys.

The officers for the coming year will be: President—E. H. Scott, Detroit Edison Co.; First Vice President—Paul S. Dwyer, University of Michigan; Second Vice President—John R. Stewart, Board of Commissioners; Secretary and District Representative—A. T. Court, General Motors Corp.; and Treasurer—R. K. Adamson, Wayne University.

HARRISBURG

The Chapter has started publication of a dittoed news bulletin to keep its members up to date on what is going on in the Chapter. The monthly programs held during the 1946–47 Season ended with the May 16 meeting at which Walter E. Burns spoke on the "Improper Use of Statistics by Banks." No additional meeting will be held until the fall series opens next September. It is planned to hold the Annual Meeting of the Chapter next October and Lester S. Kellogg, Secretary of the American Statistical Association, is scheduled to be on the program.

A special committee to investigate the need, practicability and ways and means of bringing the *Source Book of State Statistics* up to date, has been formed with F. A. Pitkin as chairman. The purpose of this Chapter project is to centralize statistical information for the benefit of State officials and other interested persons and to aid in handling inquiries for State statistics which may be received by State officials. Chapter members who have already accepted membership on the committee include: Roy Helton, (Vice Chairman) State Planning Board; Justin Cox, Department of Public Assistance; Harry Hoyle, Bureau of Employment Compensation; Erma Myers Wallis, Bureau of Employment and Unemployment Compensation; Henry Van Pelt, Department of Internal Affairs.

INDIANA

The annual election was held at the meeting on May 16. Officers for the coming year chosen at that time were: President, A. S. Thomas, Director Tax and Legislative Bureau; Vice President, Dwight Kelly, Indiana Employment Security Division; Secretary-treasurer, William Sterrett, State Department of Public Welfare. The last two meetings of the Chapter heard Wesley Arden of the International Business Machine Corporation discuss "The Use of Machines in Computing and Segregating Statistical Data," and Carl Schmid, retiring president, discuss the development of "Quality Control."

ITHACA

The Ithaca Chapter was chartered by the American Statistical Association in April. Professor J. E. Morton of Cornell University was elected its First President, and Professor H. J. Loberg, Secretary.

NEW YORK

The New York Chapter is engaged in forming an Employment Committee. Frank Lang, Manager of the Research Department of the Association of Casualty and Surety Companies, is serving as chairman. Lists of 160 members were submitted to the membership of the chapter from which to elect representatives from each of five major fields of industry to serve with Mr. Lang on the Committee. The Chapter writes that "we are meeting with Mr. Adelman of the N. Y. State Employment Service in order to strengthen our ties with other groups. Here in New York, the local engineering societies have a strong joint placement service. I see no reason why there shouldn't be an equally strong placement service for the social science group."

The Financial Markets Committee held a meeting in June to discuss whether the Federal Reserve Board has abdicated its function in the nation's monetary system; what will be the relation of the financial markets to the new World Bank; and what progressive trends are evident in railroads and industry.

NORTH CAROLINA

The last meeting of the academic year was held in Raleigh on May 16. Gertrude M. Cox, Director of the Institute of Statistics of The University of North Carolina, reported on her recent experiences in Hawaii as a consultant on agricultural experiments.

Officers for 1947–48 were elected for the North Carolina Chapter: President, H. L. Lucas, Institute of Statistics, Raleigh, North Carolina; Vice President, Harold Hotelling, Institute of Statistics, Chapel Hill, N. C.; Secretary, Russell P. Handy, Crop Estimates Division, Bureau of Agricultural Economics, Raleigh, N. C.

PHILADELPHIA

The Philadelphia Chapter voted at its May meeting to go on record as approving and seconding the action of the Chicago Chapter in calling upon Congress "to provide adequate funds, more than now in prospect, for the Bureau of Labor Statistics, for the Censuses of Manufactures and Business, and for other federal data gathering and disseminating services."

The final meeting of the 1946–1947 season was held on June 13. Albert R. Koch, formerly with the National Bureau of Economic Research and now in charge of the Business Finance Unit of the Division of Research and Statistics, Federal Reserve Board, described the Board's Survey of Bank Loans to Business.

The Chapter elected the following officers: President—Irwin Friend, Securities Exchange Commission; Vice-President—Prof. E. Douglass Burdick, Wharton School of Finance and Commerce, University of Pennsylvania; Secretary-Treasurer—Edward Bloom, Sun Oil Company.

WASHINGTON STATISTICAL SOCIETY

Dr. Isador Lubin addressed the annual meeting of the Washington Statistical Society on June 24 on the subject of "The Statistical Requirements of World Stabilization."

The officers of the Chapter elected for the year 1947–1948 are: President—Charles F. Sarle, Bureau of Agricultural Economics; Vice President—Irving H. Siegel, Veterans Administration; Secretary-Treasurer—Samuel Weiss, Bureau of Labor Statistics.

The Secretary-Treasurer reported that the Society had increased its members, acquired greater financial assets, and enlarged the attendance at meetings during the year.

"A major event of the year was the annual meeting of the American Statistical Association in Atlantic City, at which papers were presented by many members of the Society. A large group attended the meeting of the parent organization, and took part in the discussions. Attendance at the Atlantic City meeting was facilitated by obtaining three special railway cars which went directly to Atlantic City.

"This year we have resumed the custom of holding the annual meeting of the Society at a dinner, a custom which had to be suspended during the war years.

"Subjects discussed at the monthly meetings during the year included International Statistics, The National Survey of Liquid Assets, The 1947 Census of Manufactures, Labor Productivity, Material Requirements for Full Employment, and International Economic Comparisons. Attendance at the meetings has been consistently good and has exceeded that of previous years.

"The Public Opinion Section, which is in its second year, has attracted attendance nearly as large as that of the regular meetings. Subjects of discussion were Practical Problems in the Use of Mail Questionnaires, Scales of Measurement in Attitude Surveys, Measuring the Size of the Labor Force—A Problem in Attitude Measurement, and The Hiring and Training of Interviewers.

"Two special donations—one to Professor Mahalanobis and one to the libraries of war-torn countries—were made in addition to the usual operating expenses."

QUESTIONS and ANSWERS

edited by FREDERICK MOSTELLER
Harvard University

Professor Frederick Mosteller of Harvard University will edit a Questions and Answers Department for *The American Statistician.*

Readers are invited to submit questions concerning any problem in the field of statistics to the editorial office in Washington, D. C.

NEWS about MEMBERS

A HARRY ALPERT, Division of Statistical Standards, will be on leave for two months, beginning June 30, to serve as Associate Professor of Sociology at Yale University's summer session. PAUL H. ANDERSON has been appointed Economic Analyst with the Marketing Division, Office of Domestic Commerce, Department of Commerce, Washington. THEODORE W. ANDERSON has left the Cowles Commission for Research in Economics to work in the Department of Mathematical Statistics at Columbia University.

B WALTER BAUDE has been appointed Professor of Commerce at the University of Cincinnati. GILBERT W. BEEBE is now with the Division of Medical Sciences, National Research Council, Washington. MARION T. BIRD has accepted a position as a professor in the Mathematics Department of San Jose State College, California. A. H. BOWKER has taken a position in the Department of Mathematics at Stanford University, California. EDWARD C. BRYANT is teaching at the School of Commerce, University of Wyoming. ADA LILLIAN BUSH has completed the survey for the Association of American Railroads on which she was working during the war. She planned and directed a special project for the Committee for the Study of Transportation.

C DAN J. CARMICHAEL has left Boston College to accept a position with the Meredith Publishing Company in Des Moines. JOHN A. CLAUSEN is now at Cornell University. HAROLD CRAMÉR, Director of the Institute of Mathematical Statistics of the University of Stockholm, was awarded the degree of Doctor of Science, *honoris causa*, by Princeton University during the academic year 1946–47. He will be at the University of California at Berkeley during the 1947 Summer Session.

D CALVERT L. DEDRICK, Coordinator of International Statistics, has returned from a trip to South America where he consulted with census officials in Panama, Ecuador, Peru, Bolivia, Chile, Argentina, Uruguay and Brazil concerning plans for the 1950 Census of the Americas. JOHN J. DEMOTT, JR., is with the Industrial Relations Department of the Standard Oil Company in Cleveland. PAUL M. DENSEN has accepted a position with the Division of Medical Research Statistics, Bureau of Medicine and Surgery, Veterans Administration, Washington. ZYGMUNT DEUTSCHMAN is with the World Health Organization in Geneva. M. V. DIVATIA is now in charge of the office of the Statistician and Economic Adviser and Under-Secretary to the Government of Sind, Karachi, India.

E HOPE TISDALE ELDRIDGE, formerly in the Population Division, has transferred to the Food and Agriculture Organization. NORBERT L. ENRICK has taken a position with the Department of Industrial Management of the Associated Colleges in upper New York in Plattsburg.

F CLARENCE B. FINE, formerly with the Office of Price Administration, has transferred to the Bureau of Old-Age and Survivors Insurance, Social Security Administration, where he is employed as a Sampling Expert. ROBERT M. FORD has transferred from the Surveys Division of the Veterns Administration to the Office of the Statistical Assistant to the Director.

G HENRY C. GEORGE has left Donald R. G. Cowan & Associates and is now with the Libbey-Owens-Ford Glass Company in Toledo. MEYER A. GIRSHICK has resigned as statistician in the Office of the Statistical Assistant to the Director of the Bureau of the Census to accept a position with the Douglas Aircraft Corporation. CHARLES C. GROVE was appointed Visiting Lecturer in Mathematics at the University of Pennsylvania for the spring semester. CHARLES J. GUILD has accepted a position with the College of Business Administration at the University of Florida.

H CHARLES O. HARDY has left Chicago for Washington to work with the Joint Committee on the Economic Report of the United States Congress. FRANK J. HARRIS has left the University of Connecticut and is now with Purdue University. E. E. HASKINS of Northeastern University has been appointed to an assistant professorship at the Army Air Forces Institute of Technology, Wright Field, Dayton, Ohio. JAMES H. HEALY has left the University of Connecticut to take a position as Instructor in Industry at the University of Pennsylvania. PAUL HORST has been appointed Professor of Psychology in the University of Washington, Seattle.

K S. KARRER has left the Baltimore Gas and Electric Company for a position at the New Mexico School of Mines in Albuquerque. WILLIAM T. KELLEY has taken a position as Instructor of Marketing and Foreign Commerce at the Wharton School of Finance and Commerce. CARL F. KOSSACK is now with the Mathematics Department at Purdue University.

L D. N. LAWLEY has left the Department of Mathematics at Kings College, Aberdeen, and is now lecturer in Statistics at Edinburgh University. ROGER LESSARD of the Hull Technical School has accepted a position at the Ecole Polytechnique, Montreal. CESAR M. LORENZO, formerly of the Bureau of Census and Statistics in Manila, Philippine Islands, is now with the Food and Agriculture Organization of the United Nations. EDWARD D. LOWERY is now a member of the Research Department, Winchester Arms Company, New Haven, Connecticut. ESCHSCHOLTZIA L. LUCIA has left the University of California Department of Hygiene to accept a position as Consultant in the California State Department of Public Health.

M DONALD W. MACLAURY, formerly with the Kentucky Agricultural Experiment Station, is now at the Department of Poultry Husbandry, Iowa State College. MARGARET PEARL MARTIN has left the University of Minnesota School of Public Health to accept a position with the Department of Preventive Medicine and Public Health at the Vanderbilt Medical School in Nashville. LEWIS A. MAVERICK has accepted a position as professor of Economics at Southern Illinois Normal University. ELIZABETH S. MAY of the Bureau of the Budget has left to do research and writing on Federal fiscal problems. ARTHUR MCGURN has organized and is operating the Management Engineering Company in Arlington, Virginia. JACOB L. MOSAK is with the Department of Economic Affairs at the United Nations, Lake Success, N. Y.

N DAVID NOVICK is resigning from the Civilian Production Agency and going to the University of Puerto Rico.

O JAMES T. OLIVER is now with the Department of Mathematics at Oklahoma A. & M. College. BERNARD OSTLE is leaving the University of Minnesota and will now be at Iowa State College at Ames.

P OMAR PANCOAST, JR., is with the Economic Division of the OMGUS, Berlin. I. B. PERROTT, since his demobilization from the British Army, has been Lecturer in Mathematics at the College of Technology and Commerce, Leicester, England. ROSWELL

F. PHELPS has retired from his position of Director of Statistics at the Massachusetts Department of Labor and Industries and will in the future be engaged in private statistical research. KARLTON W. PIERCE has left the Office of Statistical Control of the Army Air Forces and is now with the Industrial Relations Research Department with the Ford Motor Co., in Dearborn, Michigan. KURT POHLEN has left his position with the Pennsylvania Economy League and is now with the Catholic Hospital Association in St. Louis. ADAM PORUBEN has left the Encyclopaedia Britannica Films and is working with the Personnel Division at the Metropolitan Life Insurance Company.

R J. S. RIPANDELLI is now with the Actuarial Department of the Jefferson Standard Life Insurance Company of Greensboro, North Carolina.

S ALICE H. SANDERS has left the Columbus, Ohio Health Department and is now working with the Council of Social Agencies at Indianapolis, Indiana. DAVID SCHWARTZ is with the Finance Division of the U. S. Military Government in Germany. A. HIRAM SIMON is now with the American Academy of Pediatrics in their study of child health services. HERBERT SOLOMON is now a professor in the Mathematics Department at Stanford Univesrity. JOHN R. STEHN is now a member of the Research Laboratory of the General Electric Company, Schenectady, N. Y. KENNETH STILES, formerly in the Administrative Analysis Section of the Research Services in Coordination and Planning, has transferred to the Finance Control Office.

T DONALD S. THOMPSON has left the National Bureau of Economic Research and is now Vice President of the Federal Reserve Bank of Cleveland. WILLARD L. THORP has been named the United States Representative to the Economic and Social Council of the United Nations.

V CHARLES W. VICKERY, formerly of Ohio State University, is engaged in work as a Research Consultant in New York City.

W CONWAY S. WILLIAMS has taken a position with the Industrial Management Department of Mohawk College, Utica, New York.

HOLD THAT LINE

A Plea for the Preservation of Chart Scale Rulings.

by KENNETH W. HAEMER

Not so many years ago, scale rulings were laid on with a lavish hand. No respectable statistical chart appeared in public without a mass of cross rulings to certify its scientific accuracy and to aid the reader in evaluating the plotted points.

Eventually, however, someone discovered that the thicket of grid lines not only tended to obscure the picture but actually made evaluation of the plotted points an eye-straining task. By thinning out some of the rulings, it was found, attention was focused where it should be—on the curve—and evaluation of the points, although not so precise, was quicker and easier.

But like most reforms, this one appears to be in danger of going too far: even reputable statistical journals now present charts that are ordinately and abscissally bare to a degree that stretches the limits of propriety for even statistical curves.

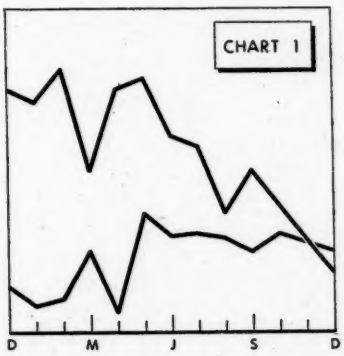
There are several reasons why a complete lack of interior ruling may be a bad thing; first of all a chart without rulings has no tabular value. Admittedly a chart is primarily a picture, and for presentation purposes should be treated as such; but in most charts it is desirable to be able to read the approximate magnitudes by reference to the scales. Such reference is almost out of the question without some rulings to guide the eye. Second, the picture itself may be misleading without enough rulings to keep the eye "honest." Although sight is the most reliable of our senses for measuring (and most other) purposes, the unaided eye is easily deceived; and there are numerous optical illusions to prove it. A third reason, not vital, but still of some importance, is that charts without rulings may appear weak and empty and may lack the structural unity desirable in any illustration.

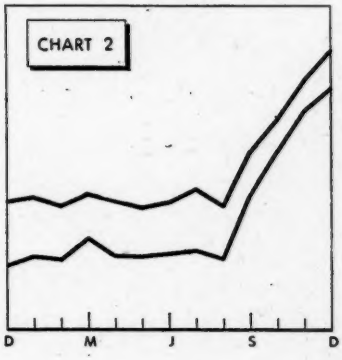
It must be acknowledged, of course, that sometimes none of these reasons has any bearing on the case; this article is concerned with pointing out typical instances when at least one of them does.

Chart 1 shows a familiar optical illusion at work. The difference between the two curves seems to be definitely greater in March than in September; but if you will draw a horizontal line through each curve at the March point you will find that the differences are the same. This example demonstrates the need for at least a few horizontal rulings on charts intended to provide point-to-point comparisons. Of course, when the general action of the series is of primary interest, and point-to-point change is of little concern, the omission of all but the major reference line does little damage.

Chart 2 illustrates an even more troublesome case. The root of the trouble is, of course, the sharp slope; because the eye tends to measure differences at right angles to the general direction of the curves, many readers will estimate that the amount difference between the two curves is less in September than in March. Actually, these differences are identical. Although it doesn't entirely overcome the tendency to misread the picture, the addition of a few vertical rulings does help to restore the correct 'point of view.' In this case the only complete remedy is to switch to a columnar form of presentation which removes the trouble very nicely; although these may be counter-balancing reasons, in individual cases, for not using columns.

To the question "how many rulings is the 'right' number?" there is unfortunately no easy answer. Charts designed to perform the work of a large amount of tabular data, being primarily tabular in purpose, obviously require closer rulings than charts designed primarily to present a picture. But even within these two groups the decision may be influenced by the precise purpose of the chart, its size and shape, the nature of the data, the degree of reading accuracy needed, and to some extent, by the style of the medium in which the chart appears. The principles to be followed in determining frequency of ruling warrant enough discussion to require a separate article.





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